## REGIONAL CLIMATE OUTLOOK FORA

Prior to the 1997-98 El Niño event, few individuals and organizations around the world had used climate forecasts in practical decision making. Weather forecasts were frequently applied to planning on a daily and weekly basis, but longer-term climate predictions had largely been confined to the research realm. With recent technological advances in forecasting climate on seasonal-to-interannual time scales and predictions of the 1997-98 El Niño, the NOAA Office of Global Programs recognized an opportunity to increase awareness of the existence and potential usefulness of climate forecasts among decision makers worldwide. Ongoing pilot applications activities that NOAA-OGP had helped develop since the early 1990s provided a well-positioned set of efforts to serve user demands for information on expected El Niño impacts. The Climate Outlook Fora, aimed at creating consensus seasonal forecasts and better understanding user needs for climate information, coupled with the timing of the El Niño event, provided a real-world laboratory in which to test the practical application of seasonal forecast information.

Working with domestic and international partners, NOAA-OGP organized and implemented Outlook Fora in Africa, Latin America, the Caribbean, and Southeast Asia. At each Outlook Forum, climate scientists fashioned probabilistic, consensus-based, seasonal forecasts, or Climate Outlooks, for given regions. The Fora involved scientists and representatives of university and government forecasting organizations, national meteorological services, and international forecast centers. Many of the Outlook Fora were held in conjunction with pilot applications design workshops, which allowed exploration of the uses of climate forecasts with users of the information from sectors such as agriculture, fisheries, water resources, and disaster preparedness. In some instances, adjunct press briefings and conferences were convened to inform the general public of the issued Climate Outlook and its potential applications.

The Climate Outlook Fora concept grew out of a need for unified, consensus forecasts identified in previous pilot forecast applications workshops and related applications activities in Africa, Latin America, and Southeast Asia. The idea was further developed in the sequence of meetings that led to the initial Southern Africa Regional Climate Outlook Forum (SARCOF) in September 1997 (see Africa section of Pilot Program for the Application of Climate Forecasts). Additional Fora were held in Africa, one focused on Western Africa and the other on the Greater Horn of Africa. The Africa Fora contributed significantly to the development and refinement of the methodology for creating consensus climate forecasts.

As planning and implementation of the SARCOF began, parallel activities were initiated in Latin America and Southeast Asia. In October 1997, NOAA-OGP coordinated and co-sponsored the first Latin American Outlook Forum in Lima, Peru. A sequence of four additional Outlook Fora were implemented by NOAA-OGP and its partners in Latin America and the Caribbean during the 1997-98 El Niño (see Table 1). Southeast Asia conducted its Outlook Forum in February 1998. Forecast applications and user outreach were a major focus at the Latin American, Caribbean, and Southeast Asian Fora, as reflected by the pilot applications design workshops and conferences.

In the following chapter, the general methodology for the planning and implementation of the Outlook Fora is outlined, the basic structure of the Outlook Fora is described, and Outlook maps and accompanying text are included. An evaluation of each forecast is also provided. The description for each Forum reflects the programmatic emphasis in a particular region. In the Southern Africa section, for example, priority is given to forecast production, while for Latin America, the Caribbean, and Southeast Asia, the primary emphasis is on applications workshops. Summaries of survey results from Southern Africa and Latin America and the Caribbean are also included. General recommendations regarding forecast creation, dissemination, and application from all of the Outlook Fora are summarized at the conclusion of this section.

NOAA-OGP's primary partners in the Outlook For included the United States Agency for International Development Office of Foreign Assistance (USAID-OFDA), Disaster International Research Institute for Climate Prediction (IRI), the European Network for Research in Global Change (ENRICH), the World Meteorological Organization (WMO), the Inter-American Institute for Global Change Research (IAI), NOAA's Climate Prediction Center (NOAA-CPC), and the United Kingdom Meteorological Office (UKMO). In addition, each event was supported by one or more local or regional institutions. The date, place, forecast region, local hosts

and co-sponsors for the Outlook Forum are listed in the following table. The institutions listed in the table represent those institutions which played major sponsoring and organizational roles at each Forum; the list of participating institutions is considerably longer, and is included in each Climate Outlook description. The large number of organizations involved attests to the fact that the Outlook Fora were cooperative efforts that required the dedicated support of individuals and institutions around the world. Without the contributions from these groups, the Outlook Fora conducted during 1997-98 would not have been possible.

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<sup>&</sup>lt;sup>12</sup> The approximate location of each Outlook Forum is shown on the document cover.

## Climate Outlook Fora 1997-98

Date	Place	Target region	Local host	Co-sponsors		
AFRICA						
September 1997	Kadoma, Zimbabwe	Southern Africa	Zimbabwe Met. Service	NOAA-OGP, WMO, ENRICH, SATCC, IRI, UKMO		
December 1997	Windhoek, Namibia	Southern Africa	Namibia Met. Service	NOAA-OGP, WMO, ENRICH, SATCC, IRI, UKMO		
February 1998	Nairobi, Kenya	Greater Horn of Africa	DMC Nairobi	USAID-OFDA, USAID-FEWS, IAD, KMD, NOAA-OGP, UNEP, UNDP, WMO		
May 1998	Abidjan, Ivory Coast	Western Africa	Côte dí Ivoire Met. Service	NOAA-OGP, World Bank, USAID-OFDA, MEDIAS, START, ACMAD, ICRISAT, ECA, WMO		
May 1998	Pilanesberg, South Africa	Southern Africa	S. African Weather Bureau	NOAA-OGP, ENRICH, WMO, SATCC, IRI, USAID-OFDA, UKMO		
		LATIN AMERI	CA & CARIBBEA	N		
October 1997	Lima, Peru	Pacific S. America	INPESCA, IGP, Sealand Advisory Services, Inc.	NOAA-OGP, IAI, WMO, IGP, INPESCA, IRI, SeaLand Advisory Services		
December 1997	Montevideo, Uruguay	Southeast S. America	Uruguay Rural Association	NOAA-OGP, IAI, WMO, IRI, Uruguay Rural Association		
January 1998	Fortaleza, Brazil	Northeastern S. America	FUNCEME, INPE	NOAA-OGP, IAI, WMO, IRI, FUNCEME, INPE		
May 1998	Panama City, Panama	Mesoamerica	CATHALAC	NOAA-OGP, USAID-OFDA, WMO, IRI, CATHALAC, INRENARE, IAI		
May 1998	Kingston, Jamaica	Caribbean	UWI, ODPEM	USAID-OFDA, NOAA-OGP, WMO, IAI, UWI, IRI, ODPEM		
SOUTHEASTASIA						
February 1998	Bangkok, Thailand	Southeastern Asia	ADPC	USAID-OFDA, NOAA-OGP		

## Acronym Key

ACMAD African Centre of Meteorological Applications for Development

ADPC Asian Disaster Preparedness Center

CATHALAC Centro del Agua del Trópico Húmedo para América Latina y el Caribe (Panama)

DMC Drought Monitoring Centre (Nairobi)
ECA Economic Commission for Africa

ENRICH European Network for Research in Global Change

FUNCEME Fundação Cearense de Meterologia e Recursos Hídricos (Brazil)

IAD Intergovernmental Authority on Development

IAI Inter-American Institute for Global Change Research

ICRISAT International Crops Research Institute for the Semi-Arid Tropics

IGP Instituto Geofísico de Peru

INPE Instituto Nacional de Pesquisas Espacias (Brazil)
INPESCA Instituto Peruano de Investigaciones Pesqueras

INRENARE Instituto Nacional para Recursos Naturales Renovables (Panama)

IRI International Research Institute for Climate Prediction

KMD Kenya Meteorological Department

MEDIAS Réseau de recherche régionale sur les changements de l'environnetment global

dans le Bassin Méditerranéen et l'Afrique Subtropicale (France)

NOAA-OGP National Oceanic and Atmospheric Administration Office of

Global Programs (USA)

ODPEM Office of Disaster Preparedness and Emergency Management (Jamaica)

SATCC Southern African Transport and Communications Commission

START Global Change System for Analysis, Research, and Training

UKMO United Kingdom Meteorological Office

USAID-FEWS United States Agency for International Development Famine Early

Warning System

USAID-OFDA United States Agency for International Development Office of Foreign

Disaster Assistance

UNDP United Nations Development Programme
UNEP United Nations Environment Programme
UWI University of the West Indies (Jamaica)

WMO World Meteorological Organization

### **Methodology**

Organizational elements of the Climate Outlook Fora included identifying participants and local organizers, developing a process for Outlook creation and presentation, and recognizing and taking advantage of regional distinctions. Each element was key to meeting the primary objectives of the Outlook Fora, which included:

- Developing and communicating a consensus seasonal Climate Outlook;
- Facilitating research cooperation and data exchange within and between regions;
- Improving coordination within the climate forecasting community; and
- Creating and enhancing a regular dialogue between producers and users of the climate information.

It was also anticipated that conduct of the Outlook Fora would encourage regional development of self-sufficient, and ultimately permanent, forecast-production and distribution activities. The following section is divided into three parts, the first of which describes initial planning and organization of the Outlook Fora. The second describes the creation of the Climate Outlooks, and the third is a description of the approach used to compare Climate Outlook projections with observations.

## Planning and Organization

### Identifying participants

In order to achieve the primary objectives, it was essential that key participants in each region be identified. The science of climate forecasting is in its infancy, and therefore there is a relatively small group of people with background and experience in the field. Much of the current forecasting capability has evolved from university or government research centers, so much of the expertise in global and/or regional climate modelling comes from these institutions. To refine and down-scale the relatively large-scale climate forecasts distributed by government and university researchers, it was recognized meteorological expertise of National that

Meteorological and Hydrological Services (NMHS) would be an essential ingredient to a successful Climate Outlook Forum. Representatives of NMHS have access to the historical climate records often used for empirically-based forecasts, the knowledge of local climate (e.g., the effect of mountainous regions on rainfall-distribution patterns), and an extensive network of people and mechanisms in the field capable of disseminating climate forecasts. Each Climate Outlook Forum was multilateral and multi-institutional, bringing together participants and organizations throughout each region to create a consensus.

#### User/producer interaction

Potential users of the forecast information attended the Climate Outlook Fora to help shape the final product and identify uses of the information. By convening meetings which included both forecast users and producers, dialogue between the two groups developed, allowing for mutual exchange of perspectives, with the intention of maximizing forecast utility within the limits of predictive capabilities. For example, at the Outlook Forum for the Caribbean, members of the natural disaster preparedness community exchanged ideas with the forecasters on how climate information could be applied to help mitigate natural disasters such as El Niño-related droughts and floods, and on what type of information would be most useful (e.g., precipitation, temperature). In return, the forecast producers outlined the limitations of available climate forecasts (e.g., broad spatial resolution, scientific uncertainty) and the methods used to develop them, in many cases a combination of empirically and dynamically-based projections (see Climate Outlook Creation section).

#### Local hosts

Although NOAA-OGP consulted on the organization and implementation of all of the Fora, much of the logistical and preparatory work for each meeting was conducted by local institutions. For example, in Panama, the Centro del Agua del Trópico Húmedo para América Latina y el Caribe (CATHA-

LAC) was the primary organizer of the Mesoamerica Outlook Forum. In each of the three regions in Africa, Outlook Fora activities were organized around a regional meteorological institution: the Drought Monitoring Centre (DMC) Harare for Southern Africa, the DMC Nairobi for the Greater Horn of Africa, and the African Centre of Meteorological Applications for Development (ACMAD) for West Africa and the Sahel. These WMO-supported regional institutions formed the nucleus of partnerships between National Meteorological and Hydrological Services (NMHS), university researchers, and international forecasting and research organizations. Local hosts have a unique knowledge of the region, and their leadership was a critical factor in the success of the Climate Outlook Fora. For climate forecasts to be created and used on a regular basis in these regions, a sense of ownership of the climate forecasting and application process, such as that fostered through local organization of the Outlook Fora, is essential.

#### Sponsorship

Co-sponsorship from multiple organizations was a key element of every Outlook Forum convened during 1997-98. The major partners in the Climate Outlook Fora included organizations from both the forecasting and applications communities at national, regional, and international levels. Funds provided by these organizations covered not only the cost of the meetings themselves, but also participants' travel stipends. Without travel sponsorship, many key participants would not have been able to attend. Full representation in each region allowed for the creation of what were truly consensus forecasts. By simply assembling members of the climate forecasting community together in one place, the Climate Outlook Fora also encouraged research cooperation and data exchange within and between regions.

# Climate Outlook Creation and Distribution

#### Tercile probabilistic forecasts

There are two main options for producing a consensus climate forecast. The first is a deterministic prediction based on a weighted average of all contributing forecasts. For example, a forecast for "above-normal rainfall for January to March, 1998," accompanied by a statement outlining confidence in the prediction and details of alternate possibilities, would be deterministic. This option, while generally easy to understand, does not necessarily account for the range of possibilities within a naturally variable climate system.

Another option is a probabilistic forecast, stated as a probability distribution where confidence information is incorporated into the prediction itself. If a probabilistic forecast of "60% probability of belownormal precipitation," for example, was reduced to a simpler deterministic forecast (i.e., below-normal, or dry), it would ignore the fact that in any given year and location, wet conditions may still prevail. For this reason, climate projections generated at the Outlook Fora were presented in terms of likelihood of above-, near-, or below-normal precipitation. By separating the possible outcome into three categories, and assigning a probability value to each, the forecasts were presented as tercile probabilistic forecasts (see Climate Outlook maps and Empirical and Dynamical models section). Although the probabilistic approach is new and unfamiliar to some forecast users, it better accounts for the chaotic nature of the climate system than deterministic forecasts. Over an extended period of time, probabilistic projections based upon statistical and dynamical modelling can provide an edge in decision making.

#### Empirical and dynamical models

Throughout the series of Outlook Fora, nationallevel forecasts tended to be empirical in nature, that is, based on historically observed climate patterns in a given area. In all cases, the Outlooks were rainfall projections. Precipitation, as opposed to temperature, was the variable of most interest to the users present, since it is the primary factor influencing flooding and drought, the most severe impacts associated with El Niño. The historical precipitation record for a given region was generally divided into thirds — or terciles — of above-, near-, and belownormal rainfall. For a 30-year record, each tercile would cover 10 years. In a typical year, there is equal probability that rainfall will fall into the above-, near-, and below-normal categories (33.3% chance for each category. This equal probability distribution is referred to as "climatology". During El Niño years, there is a shift in the probability that rainfall could fall equally into the three categories. For example, in a given area, 70% of El Niño years may fall into the wettest third, 20% into the nearnormal third, and 10% into the driest third of the historical record. With the knowledge that an El Niño is underway, or is predicted to occur (based on observations and models of sea-surface temperatures in the equatorial Pacific), the likelihood that precipitation will be in the wettest third of the historical record is 70%, while there is only a 10% likelihood it will fall into the driest third.

The forecasts were also based in part on computer model simulations of the climate system. Computer models simplify the climate system into a series of discrete, three-dimensional boxes, where the movement of water, air, and energy between the boxes is described mathematically, based on known physical laws. Observations of the climate system at a given time are programmed into these models, such as unusually warm sea-surface temperatures in the equatorial Pacific during El Niño years. The models are then run to determine how the climate system will evolve over a given period of time. In some cases models are run multiple times, using slightly different initial conditions. These types of "ensemble" model runs provide a range of possible

climate conditions within the model, from which probabilistic forecasts can be made.

#### Forecast assembly

To create a consensus forecast, it was first necessary to ensure that the Outlook participants understood the forecast methodology used. Preparation and training varied depending on the Outlook Forum. For example, in Southern Africa, the better part of two days were dedicated to training sessions which reviewed statistical and dynamical prediction methods, the proposed consensus methodology, and user community needs, providing participants with groundwork to produce a seasonal climate forecast. In other regions, such as Mesoamerica, descriptions of the forecast methodology and presentation were distributed to participants prior to the Outlook Forum.

The next step was to reach a consensus regarding the likely evolution of sea-surface temperatures (SSTs) and other important factors which would provide boundary conditions for the climate system over the course of the upcoming season. Although Pacific SSTs (and hence the strength and duration of the El Niño) were generally the primary climatic forcing factor considered at the Outlook Fora, individual regions considered other factors as appropriate, such as SSTs in the Indian and Atlantic oceans. For details on the assumptions made for each Outlook, see the descriptions that accompany the Outlook maps.

After reaching a consensus on background climate conditions, individual country rainfall forecasts based on empirical and dynamical methods were presented. In many cases, forecasts for a given area or for adjoining countries were very similar; in others there were discrepancies. In the latter case, participants would discuss the opposing forecasts and would eventually reach a common understanding. At each Outlook Forum, the process of creating a consensus forecast was mediated by a representative from the International Research Institute for Climate Prediction (IRI). This person acted as the chair of the Outlook Forum, facilitated discussions among forecasters, and provided a third-party perspective to ensure the forecasts were based on

historical patterns, computer simulations, and/or climatic mechanisms typical of El Niño events.

Once the regional map was drawn and agreed upon, forecast probabilities for each climatic subregion were calculated and drawn onto the map. Ideally, the individual forecasts which serve as inputs to the Outlook Fora would have had a consistent format, covering identical regions and time periods, as well has exhibiting standard expressions of forecast skill. Given the relative youth of forecasting science, however, no single method has been agreed upon. Hence, all of the Fora relied upon subjective interpretation of inputs to generate a consensus.

#### **Outlook** dissemination

The mere existence of a forecast does not necessarily imply that it will be used. Practical application requires that the forecast be disseminated responsibly to a broad group of potential users. Several methods were employed both during and after the Outlook Fora to distribute the forecasts. Press conferences were given at many of the Fora to inform representatives of government, industry, media, and the general public about El Niño-related climate conditions, possible impacts, and methods to utilize climate information. This venue allowed participants to ask questions about climate-forecast products and potential applications in climate-sensitive sectors. Pilot-applications design workshops provided opportunities for sector-specific development of projects to utilize Climate Outlook information. Many representatives of NMHS also held press conferences and workshops after returning to their countries.

Outlook maps and accompanying descriptions were posted on the internet by the IRI and NOAA-OGP immediately following each Outlook Forum.<sup>13</sup> Through posting on the World Wide Web, the Outlooks were available to anyone with basic internet access. In the Outlook descriptions, care was taken to outline certain caveats and to refer specific questions

to NMHS representatives and other national organizations, many of whom attended the Climate Outlook Fora and were familiar with the capabilities and limitations of the consensus forecasts.

# Comparison of Climate Outlooks and Observations

An evaluation of the Climate Outlook maps is necessary to determine the accuracy of the forecast given in each region. Ideally, a measure forecast skill would involve a quantitative comparison of the forecast and observed conditions over several seasons. Since the forecasts at the Outlook Fora were probabilistic in nature, as opposed to deterministic, it is not possible to determine if they were "correct" or "incorrect." An area forecast to have a 60% chance of above-normal precipitation may have received above-normal rainfall, and yet the forecast would not technically be "correct." The forecast was that 6 out of 10 times the precipitation would, on average, fall in the upper-third of historically-observed amounts. Since we have only one sample (in this case a season), as opposed to 10, it is difficult to rigorously test forecast skill.

One way to evaluate a probabilistic forecast is to assume it was effectively deterministic. For instance, if the Outlook indicated a 60% chance of abovenormal rainfall, it is assumed that the forecast was for above-normal rainfall. Although this method ignores the probabilities assigned to terciles, it is a necessary assumption when evaluating a probabilistic forecast for a single season. This approach was taken by SARCOF participants, who then quantitatively determined how well the Outlooks for southern Africa matched observations for this region; the methodology used is discussed in the SARCOF portion of the African Outlook Fora section.

Meetings tentatively scheduled for Mesoamerica, portions of South America, and the Greater Horn of Africa and West Africa will evaluate the initial Climate Outlooks in each region.<sup>14</sup> In the mean time,

Outlook maps and descriptions created at the Outlook Fora were digitized by the IRI and are available at <a href="http://iri.ucsd.edu/forecast/sup/index.html">http://iri.ucsd.edu/forecast/sup/index.html</a> and on the NOAA-OGPwebsite at <a href="http://www.ogp.noaa.gov/enso/#Global\_Climate">http://www.ogp.noaa.gov/enso/#Global\_Climate</a>.

<sup>&</sup>lt;sup>14</sup> Please contact NOAA-OGPfor names or regional representatives responsible for evaluating the Climate Outlook for a given region.

we qualitatively compare expected conditions and actual observations in these regions to determine an approximate measure of forecast reliability. Following each probabilistic Climate Outlook map is a map of estimated precipitation over the forecast period (except for SARCOF). These maps were provided to NOAA-OGP by NOAA-CPC and the IRI. The data for the observation maps is a combination of land-based and satellite-derived precipitation values for the period 1979-1995. Ideally, the observational period would be 30 years or longer, but collection of the satellite data did not begin until the mid-1970s.

For the purposes of the qualitative evaluations, we define a forecast with 45%-or-greater probability of above-normal precipitation as equal to a forecast for above-normal rainfall. Similarly, a forecast

with 45%-or-greater probability of below-normal precipitation is defined as equal to a forecast for below-normal rainfall. Although the 45% value is somewhat arbitrary, it is significantly greater than climatology (33.3%), indicating the climate system had at least a moderate tendency for producing rainfall amounts in a particular tercile. We recognize that the forecasts were probabilistic in nature, however, and that by definition there will be instances when observed conditions fall into terciles with low predicted probabilities. In terms of the observational data, normal precipitation is defined as the 16-year mean over the period from 1979-1995. We define above- or wetter-than-normal precipitation as greater than 125% of normal (or mean) rainfall while below- or drier-than-normal is defined as less than 75% of normal.

#### Africa Outlook Fora

The first Climate Outlook Forum in Africa occurred in Harare, Zimbabwe, as part of the Southern Africa Regional Climate Outlook Forum (SARCOF). This meeting, which occurred during September 1997, involved the development of a methodology for combining existing climate information into one user-friendly product.<sup>15</sup> Using the methodology developed by SARCOF, additional Outlook Fora were held in the Greater Horn of Africa (February 1998) and Western Africa (May 1998). Prior to these meetings, users in Africa were faced with several different seasonal forecasts which were presented in different formats, with a variety of techniques and lead times. SARCOF and similar activities in other parts of Africa provided a regional process for coordinated production, dissemination, interpretation, and use of forecast information as well as a framework in which to assess the effectiveness of the season's activities and translate lessons-learned into future actions.

Products from the African Outlook Fora follow in the next several pages. Maps of forecast precipitation are given for:

- Southern Africa, October-December 1997
- Southern Africa, December 1997-March 1998
- Southern Africa, January-March 1998
- The Greater Horn of Africa, March-May 1998
- Western Africa, July-September 1998

Accompanying each map is a description of the methodology for producing the Outlook, a brief summary of the forecast conditions, and participating organizations. Also included is a general description of the quantitative evaluation method used by SARCOF participants to evaluate the Outlooks for southern Africa. For the Greater Horn of Africa and Western Africa, maps of estimated precipitation amounts expressed in terms of percentage of normal rainfall are provided, along with qualitative evaluations of the Climate Outlooks for these regions.

# Southern Africa Regional Climate Outlook Forum (SARCOF)

#### SARCOF 1:

#### Pre-Season Outlook - September 1997

The primary purpose of the first SARCOF meeting was to develop a consensus methodology for producing climate forecasts in southern Africa. This meeting included training and capacity-building components to address the range of forecasting research and production capacity across the region. Participants in the Pre-Season Outlook meeting included producers of climate-information products from regional and international forecasting centers, personnel from National Meteorological Services responsible for national climate forecasts, and a few specialists in food security and disaster preparedness. The SARCOF process helped build a sense of community among these groups through overcoming institutional barriers to cooperation.

Activities at the September 1997 meeting followed the general Outlook methodology, and also included:

- Tutorials on climate mechanics, and the creation and interpretation of climate predictions;
- Training sessions, including forecast verification, probabilities, techniques of forecast application, and user needs;
- Presentation of user/intermediary requirements, based in part on outcomes from the Victoria Falls meeting;
- Presentations of regional climate information products;
- Discussion of products, models, and methodologies; including quality selection criteria, regionalization of forecasts, and forecast parameters;

<sup>15</sup> The SARCOF was a follow-up activity to the Workshop on Reducing Climate-Related Vulnerability in Southern Africa (October 1996, Victoria Falls, Zimbabwe).

- Investigation of methodologies for consensus Outlook development; and
- Discussions on Outlook distribution and dissemination.

The Outlook Forum process in Southern Africa benefitted from the fact that much of the design for SARCOF occurred prior to predictions of the 1997-98 El Niño event. This lead time allowed for thorough advance planning and resource allocation. This advance planning, combined with the foresight of SARCOF's many cosponsors, permitted the funding and preparation for a three meeting approach, which included a mid-season meeting to update the initial outlook and a post-season meeting to evaluate the Outlook Forum process as a whole. Although a mid-season meeting resulted in a significant additional expense, it was climatologically wise, as southern Africa covers a relatively large area. Its rainy season also spans several months, from approximately October to March, with temporal differences across the region.

#### Outlook evaluation

Using input from SARCOF participants, representatives from the Cooperative Institute for Mesoscale Meteorological Studies at the University of Oklahoma, USA, and the Drought Monitoring Centre (DMC), Harare, Zimbabwe, developed a method to quantitatively evaluate the SARCOF consensus forecasts.<sup>16</sup> Total rainfall for the season in question was determined and ranked according to the historical precipitation record from 1961-1994 at any given rainfall measurement station. For example, October-November-December (OND) 1997 was the tenth driest OND from 1961 to 1994 for one observation station, 15th driest for another, and so on. The rankings were then gridded spatially (on a 2° latitude by 2° longitude scale) and it was determined whether each grid box fell into the above-, near-, or below-normal tercile based on the period 1961 to 1994. By gridding the observational

data at a small scale relative to the Climate Outlook, it was possible to account for spatial variability within forecast regions.

The forecast map was then overlaid on the gridded rainfall data and scored based on the number of times it matched observations. An exact match was defined as a "hit," and if observations matched one of the two terciles with greatest probability (for example, a forecast for near- to above-normal rainfall), it was considered a "half hit." Ahit was worth 1 point, and a half hit was worth 0.5 points. Since there were a total of 124 grid boxes over the southern Africa region, a perfect forecast would receive a score of 124, or hit rate of 100%. Arandom forecast would, on average, produce a hit rate of 33%. (Similarly, a forecast for above-normal conditions everywhere in the region would have an average hit rate of 33%.) Additional forecast verification techniques (e.g., the Heidke Hit Skill Score, LEPS, and Relative Operating Characteristic) were also used to evaluate SARCOF forecast guidance, but they are not summarized here.

The Southern Africa Regional Climate Outlook Forum produced three precipitation forecasts for the same region. At the first SARCOF meeting, two forecasts were produced, one for October to December 1997 (Map A), and the other for December 1997 to March 1998 (Map B). The evaluation for the October to December 1997 Outlook indicates the grid boxes in northern Tanzania were all hits (Figure 1). Southern Tanzania, Northern Namibia, eastern Botswana, northeast South Africa, and most of Zambia, Malawi, and Mozambique had half hits. Southern Namibia and Botswana, and eastern portions of South Africa experienced hits, while other regions, such as northern Botswana and eastern South Africa had neither hits nor half hits. The overall hit rate for southern Africa over the Outlook period was approximately 50%, well above the chance level (33%), but far from perfect.

<sup>16</sup> The information presented here is only a partial summary of the SARCOF validation method and results. Please consult the UKMO website to obtain a comprehensive description of the validation techniques: <a href="http://www.meto.gov.uk/sec5/NWP\_old/NWP\_pef\_ensarcof/report2/projassess2.html">http://www.meto.gov.uk/sec5/NWP\_old/NWP\_pef\_ensarcof/report2/projassess2.html</a>

The Outlook for December 1997 to March 1998 indicated fewer hits than the OND 1997 Outlook (Figure 2). Most of the region north of South Africa's northern border was characterized by half hits, with a few grid boxes showing neither hits nor half hits. The Outlook for most of South Africa was off by one tercile (forecast for below-normal, but receiving near-normal precipitation), although a few

grid boxes in the extreme northern and western portions indicated hits. Overall, the hit rate for the October 1997 to March 1998 Outlook was 37%, slightly higher than the chance rate (33%). This Outlook was evaluated using rainfall data from only January to March 1998, however, and the hit rate would likely increase if December precipitation values were included.

#### Climate Outlook - Rainfall

Statement from the Southern Africa Regional Climate Outlook Forum 12 September 1997 Kadoma, Zimbabwe

#### CLIMATE OUTLOOK FORUM

From 8-12 September 1997, a Southern Africa Climate Outlook Forum convened to formulate consensus guidance for the 1997-98 season in southern Africa. The Forum comprised Meteorological Services from SADC (Southern Africa Development Community) countries, and climate scientists from universities and international research institutes. These specialists reviewed the state of the global climate system and its implications for southern Africa. One of the principal factors taken into account is the major El Niño event ongoing in the tropical Pacific Ocean. Recent El Niño occurrences such as in 1982-83, 1991-92 and 1994-95 resulted in low rainfall across much of southern Africa south of 10 degrees South and disrupted climate patterns around the globe.

Participants at the Forum included representatives of Meteorological Services from eleven SADC countries (Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Swaziland, South Africa, Tanzania, Zambia and Zimbabwe) and climate scientists and other experts from national, regional, and international institutes (DMC - Harare; Universities of Witwatersrand, Zululand and Zimbabwe; SADC Food Security Technical and Administrative Unit; SATCC; WMO; IRI; NOAA-OGP; NOAA-CPC; the USAID; the U.K. Meteorological Office; IMGA/CNR-Bologna; and the World Bank.)

#### **OUTLOOK**

The Outlook divides the 1997-98 season into two periods (October-November-December and December-January-February-March; Maps A and B respectively). The experts provided probability distributions to indicate the likelihood of below-, near- or above-normal rainfall for each subregion (see Maps). Users are strongly advised to contact their

National Meteorological Service for interpretation of this Outlook and for additional guidance.

In the first period, above-normal rainfall is expected in northern Tanzania (Short Rains) from October through December (Map A). In October through November, rainfall is not expected to depart significantly from normal throughout much of the rest of the region. Although the seasonal onset may be favourable, the possibility of a later downward trend should be considered. One exception is the extreme southern tip of South Africa, where above-normal rainfall is expected. The other is for Mauritius, where below-normal rainfall is expected.

December through March is the main rainy season for much of southern Africa. During this period, northeastern regions are expected to experience normal- to above-normal rainfall (Map B). Proceeding southward, there is a distinct trend towards below-normal rainfall, which may be significantly below normal over South Africa, southern Mozambique, Lesotho, and Swaziland. The northern extent of this region, over which significantly below-normal rainfall may occur, is uncertain at this stage. Above-normal rainfall is expected for Mauritius.

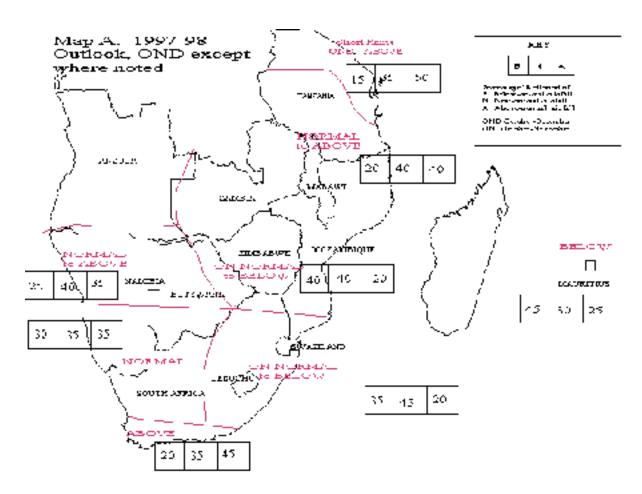
Much of the Outlook is attributable to the severity and expected persistence of the current El Niño event into 1998. This and other factors affecting southern Africa's climate were assessed using coupled ocean/atmospheric models, physically-based statistical models and expert interpretation. In some areas there was lack of agreement among the models. In particular, prospects for Malawi, southwestern Zambia and northern Namibia in December through March were uncertain, uncertainties that are reflected in the probabilities and which may be resolved in a later update.

The current status of seasonal-to-interannual forecasting allows prediction of spatial and temporal averages, and may not fully account for all factors that influence regional and national climate variability. This Outlook is relevant only to seasonal time scales and relatively large areas, and local variations may occur.

## **Consensus Climate Guidance**

## Southern Africa Regional Climate Outlook Forum

12 September, 1997 Kadoma, Zimbabwe

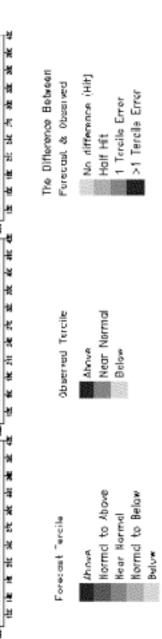


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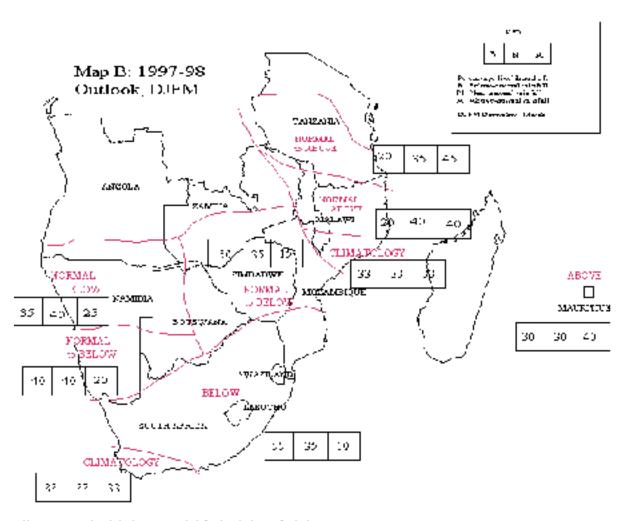
Fig.1 Verification of Kadoma OND Forecast (c) Difference (b) Observed (a) Forecast



## **Consensus Climate Guidance**

## Southern Africa Regional Climate Outlook Forum

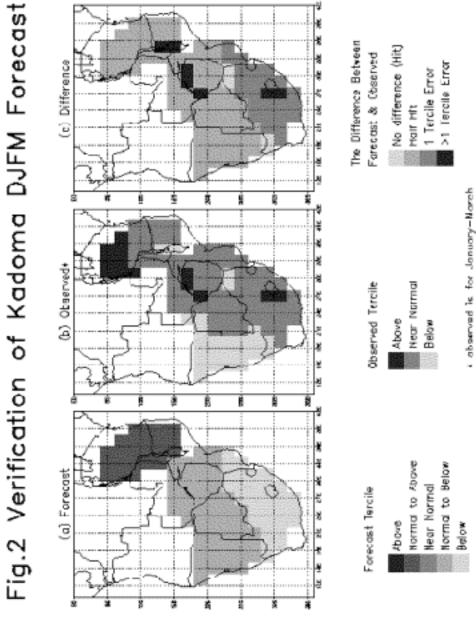
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# SARCOF2: Mid-Season Correction - December 1997

The Pre-Season Outlook was updated at the December 1997 Mid-Season Correction meeting in Windhoek, Namibia. The primary objectives of this meeting were to adjust the predictions made at the Pre-Season Outlook meeting and work towards a consensus Outlook for the remainder of the rainy season. Activities at the December, 1997 meeting included:

- Assessment of early-season performance and dissemination;
- Discussion of forecast quality criteria and regionalization of forecasts;
- Assessment of progress with employing standard verification system methodology and standard data set for forecast validation;
- Adjustment of the evolving consensus Outlook methodology;
- Discussion of the current state of the climate system;
- Presentations and discussion of regional climate information products;
- Feedback from users and update on use of forecast and monitoring products; and
- Outlook distribution and dissemination.

At the Mid-Season meeting a set of forecast subregions in Southern Africa were proposed based

on the first principal component of rainfall over the subcontinent. These regions were shown to be consistent with the main sources of predictability, including sea-surface temperatures in the eastern equatorial Pacific region and in the Indian Ocean. In general, SARCOF participants felt that the regionalization proposed was too large and that additional research needed to be conducted to achieve greater regional detail. It was also recognized that with increased detail, forecast skill would likely decrease. In the end, Forum members elected to defer until future SARCOF meetings the definition of climatic subregions and the seasons for which the forecast should be set.

#### Outlook evaluation

At the second SARCOF meeting a Climate Outlook was created for January to March 1998.<sup>17</sup> The evaluation for this Outlook indicates hits for grid boxes in northeastern Tanzania, southern Tanzania, northern Mozambique, southern Namibia, most of Malawi and portions of northern Zambia (Figure 3). Half hits were common in the central part of the region, including southern Mozambique and Zambia, northern Namibia, northeastern South Africa, and most of Zimbabwe. Areas with neither hits nor half hits included the northern edge of Zimbabwe, and most of Botswana and South Africa. The hit rate for the Outlook period was approximately 45%, slightly below that for the October-November-December 1997 Outlook, but above the chance level of 33%.

<sup>&</sup>lt;sup>17</sup> See the Preseason Outlook meeting section for a general description of the method used to evaluate the SARCOF forecasts.

#### Climate Cutlook - Rainfall

Statement from the Southern Africa Regional Climate Outlook Forum 18-19 December 1997, Windhoek, Namibia

#### **SUMMARY**

Below-normal rainfall conditions over the period January-March 1998 are expected over much of continental southern Africa south of about 15°S. The indications for below-normal rainfall are strongest in the western and central parts of this region. Further north, near-normal rainfall is expected, except in northern and eastern Tanzania during January-February, where above-normal rainfall is expected. Over Mauritius and the south-western tip of South Africa, near-normal to above-normal rainfall is expected.

#### THE CLIMATE OUTLOOK FORUM

From 18-19 December 1997, a Southern Africa Climate Outlook Forum convened to formulate consensus guidance for the January-March 1998 season in southern Africa. This Forum was a mid-season meeting to update the information provided by an earlier Forum that convened in Kadoma, Zimbabwe on 8-12 September 1997. The Windhoek Forum reviewed the state of the global climate system and its implications for southern Africa. One of the principal factors taken into account is the major El Niño event on-going in the tropical Pacific Ocean. Recent El Niño occurrences such as in 1982-83, 1991-92 and 1994-95 resulted in below-normal rainfall across much of the SADC region and disrupted climate patterns around the globe.

#### METHODOLOGY

The regional climate assessment began with consensus agreement that the current El Niño will remain over the forecast period (January-March 1998). This and other factors affecting southern Africa's climate were assessed using coupled ocean/atmosphere models, physically-based statistical models, and expert interpretation. The current status of seasonal-to-interannual forecasting allows prediction of spatial and temporal averages, and may not fully account for all factors that influence regional and national climate variability. This Outlook is relevant only to seasonal time scales and relatively large areas, and local variations may occur. Users are strongly advised to contact their National Meteorological Service for interpretation of this Outlook and for additional guidance.

The experts provided probability distributions to indicate the likelihood of below-, near- or above-normal rainfall for each subregion (see Map). Above-normal rainfall is defined as within the wettest third of recorded precipitation totals in each region over the period 1961 to 1990; below-normal rainfall is defined as within the driest third of precipitation totals; near-normal is the third centered around the climatological median.

#### **OUTLOOK**

January through March covers much of the remainder of the rainy season for most of SADC. Exceptions are the northern and eastern part of Tanzania, and the far south-western part of South Africa.

Before the Tanzanian Long Rains, which usually start in March, above-normal rains are expected in northern and eastern Tanzania. The guidance on the map for this region is for January and February only and no guidance is provided for March. Near-normal rainfall is expected over the south-western half of Tanzania, northern and eastern Zambia, central and northern Malawi, and northern Mozambique. Near-normal rainfall is expected also over northwestern Zambia and the far north-western part of Namibia.

Over Mauritius and the southwestern tip of South Africa, near-normal to above-normal rainfall conditions are expected.

The rest of continental southern Africa continues to have an increased risk of below-normal rainfall for January-March. Below-normal to near-normal rainfall is expected in northern Namibia and the southern half of Zambia. There is a strong indication of below-normal rainfall in central and southern Namibia, most of Botswana, Lesotho, and much of South Africa.

There was some disagreement among models presented regarding how far east the strong indication of below-normal rainfall extends into northeastern South Africa, Swaziland, southern Mozambique, southern Malawi, and Zimbabwe. The strong risk of below-normal rainfall for eastern regions of southern Africa is a little less than indicated in the previous Forum Outlook, but is still considerable. Most models show no weakening of the risk of below normal rainfall in January to March in these regions.

#### **PARTICIPANTS**

Participants at the Forum included representatives of Meteorological Services from eleven SADC countries (Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe) and climate scientists and other experts from national, regional, and international institutes (DMC Harare and Nairobi; University of Zululand; Clark University; SADC Food Security Technical and Administrative Unit; SATCC; WMO; the Food and Agriculture Organization; IRI; NOAA-OGP; NOAA-CPC; USAID; the U.K. Meteorological Office; IMGA/CNR-Bologna).

Other Users at the Forum included representatives from the University of Botswana, Namibia Agricultural Union, Namibia Emergency Management Unit, Purdue University, World Vision, Namibia Department of Water Affairs, Namibia Agronomic Board, Zambia Food Reserve Agency, CICERO, Namibia Early Warning and Information System, Malawi Ministry of Agriculture and Irrigation, DFID / University of Greenwich, U.S. Department of Agriculture, and the South Africa Department of Constitutional Development.

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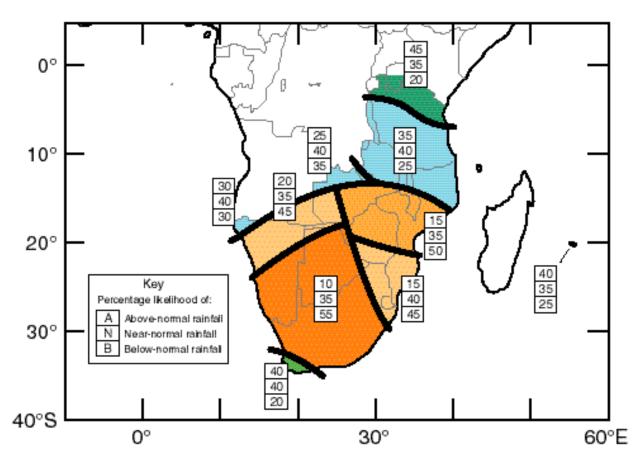
## **Consensus Climate Guidance**

## Southern Africa Regional Climate Outlook Forum

18-19 December, 1997 Windhoek, Namibia

(for list of participants and explanatory text see associated discussion)

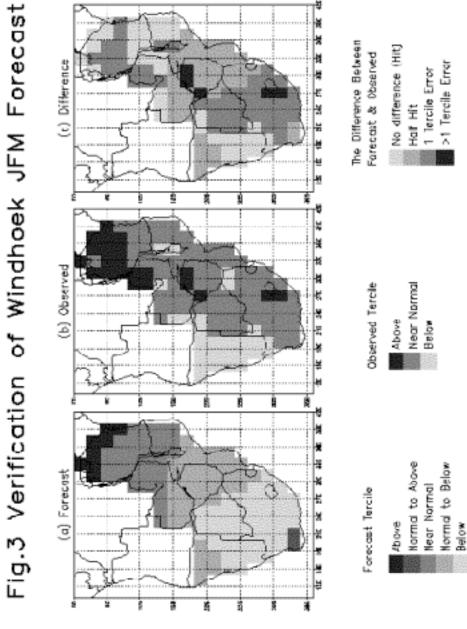
## January - March 1998



IRI INTERNATIONAL RESEARCH INSTITUTE FOR CLIMATE PREDICTION EXPERIMENTAL CLIMATE FORE CAST DIVISION

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### SARCOF3: Post-Season Assessment - May 1998

In May 1998, a third meeting was held in Pilanesberg, South Africa, to assess the skill and usefulness of the forecasts from the first two meetings from the perspective of the scientific and user communities. This meeting included many of the forecast information producers from earlier meetings and representatives of the broader regional user community, including: agriculture and food security, water resources, health, and forestry. User participation stimulated user/producer dialogue by providing an opportunity for feedback regarding forecast content, format, lead-time, delivery, and distribution. Activities at the Pilanesberg meeting included:

- User assessments of forecast performance and dissemination, including a preliminary assessment of the benefits of the Outlook for core group users;
- Assessment of the value of the predictions;
- Identification of relationships between elements of climate prediction and user activities, gaps in production and dissemination, and impediments to optimal use of forecasts; and
- Adjustment of the consensus methodology to better address user needs.

Successes of SARCOF and areas for improvement according to participants of the Post-Season Assessment Meeting are listed in the following table.

Due to the overall success of the 1997-98 process, SARCOF has continued into the 1998-99 season, with the goal of furthering previous accomplishments by addressing the needs and areas for improvement listed above. Of primary importance is the refinement of the consensus forecast process through statistical verification methods, and improved collection of climate data, for both the creation of empirically-based projections and for evaluation of the consensus forecasts. Long-term financing of SARCOF is necessary, and will be gained only through demonstrating the benefits of

consensus climate forecasts to potential national, regional, or international sponsors. Increased involvement from regional and subregional institutions and NMHS will help 1) overall coordination and planning of forecast creation and dissemination, 2) increase regional capacity to utilize forecast information, and 3) create a sense of ownership critical to sustaining SARCOF.

Workshop participants at the SARCOF meetings and other individuals interested in making use of early warning climate information have proposed several applications pilot projects. A list of pilot projects conducted during the 1997-98 rainfall season is included in the section on the Pilot Program for the Application of Climate Forecasts in Africa. Several other proposals are expected to be funded by members of an interagency group in time for the 1998-99 rainy season.

#### SARCOF Survey Results

Echoing many of the suggestions from the Post-Season Assessment meeting, results from a survey of climate forecast users indicate that the SARCOF Climate Outlooks were of value, but require improvements. (Survey results were complied and analyzed at the Natural Resources Institute, University of Greenwich, United Kingdom.) Most respondents to the survey indicated that they used SARCOF climate forecast information in their decision making during 1997-98. Decisions affected included:

- Timing and type of agricultural planting;
- Disaster (particularly drought) prevention and mitigation strategies;
- Epidemic forecasting and preparedness (e.g., malaria);
- Preparation for migratory pest outbreaks;
- Public water usage; and
- Electrical power generation strategies.

The majority of respondents indicated that in light of this experience, if similar forecast information were available during 1998-99, it would again be incorporated into their decision making processes. Responses to the SARCOF Survey also called for improvements in the Outlook product, including:

- Tailoring forecasts to predict dam levels, runoff, soil moisture, etc.;
- Providing historical sets of forecasts for comparison;
- Detailing implications of tercile values for agricultural and hydrologic situations;
- Increasing forecast dissemination and explanation by National Meteorological Services;
- Including information on rainfall distribution within the season;

- Providing Outlook in additional formats (e.g.,minimum-maximum temperatures); and
- Enhancing Outlook spatial resolution and presenting probabilities in greater detail than terciles (i.e., dividing the forecast into four or more categories).

These suggestions highlight the need for forecast producers to 1) learn more from the users about their forecast requirements, and 2) further educate user communities about the meaning and limitations of the forecasts. These issues can be addressed by continuing the cross-disciplinary dialogue initiated at the Outlook Fora, and through training and education for both forecast users and producers.

## SARCOF Successes and Needs - Post - Season Assessment Meeting $^{18}$

	Successes	Needs — Areas for improvement
General Awareness	<ul> <li>Forecast consensus throughout region</li> <li>Increased awareness of climate factors and forecasts amongst users</li> <li>Use of media and increased publicity</li> <li>Internet access to IRI, NOAA, UKMO, etc.</li> </ul>	<ul> <li>El Niño often equated with drought conditions</li> <li>Confusion between below-normal conditions and drought</li> <li>Superstitions conflicted with forecast usage</li> <li>Many users don't understand that seasonal forecasts are experimental</li> <li>Outlook didn't get to small farmers</li> <li>Formal forecast dissemination structures needed</li> <li>NMHS not the first source of forecasts</li> <li>Outlook results evaluated too hastily by users</li> <li>Media overemphasized Outlook certainty</li> <li>Bolder NMHS efforts needed to control misleading information from news media</li> <li>Packaging of forecast information not user friendly</li> <li>Need for uniform definitions for drought and other climate terms</li> </ul>
Science	<ul> <li>Consensus process resulted in fewer conflicting forecasts</li> <li>Users informed forecasters of requirements</li> <li>Users educated about terciles and exposed to forecast limitations</li> <li>Better public understanding of climate teleconnections</li> <li>Forecast lead time generally adequate</li> <li>Predictors and climate factors identified</li> <li>Diagnosed peculiarities of El Niño signal at mid-season</li> <li>Started process of understanding interactions of large-scale atmospheric flow patterns with smaller-scale climate anomalies</li> </ul>	<ul> <li>Inadequate spatial and temporal forecast resolution</li> <li>Some forecasters overconfident in their predictions</li> <li>Forecast periods do not adequately address differences in seasonal timing across the region</li> <li>Forecast lead-time not adequate for some users</li> <li>No objective method to blend the forecasts</li> <li>Difficult to maintain forecast standards</li> <li>Individual forecast inputs to Outlook not equally weighted</li> <li>Outlook consensus building still formative</li> <li>Understanding of physical climate processes weak</li> <li>Too much emphasis on El Niño for forecast creation at the expense of other factors (e.g., South Atlantic SSTs)</li> <li>Increase monitoring &amp; studies of Indian Ocean and its effect on southern Africa climate</li> <li>Users lack full understanding of probabilities, terciles</li> <li>Terciles inadequate - extreme events need coverage</li> <li>Need for forecast in Geographic Information System format</li> <li>No sectoral interpretation (e.g., food security) for forecast by SARCOF</li> <li>Historical forecast information needed</li> <li>Improve regional rainfall observation network</li> </ul>

<sup>&</sup>lt;sup>18</sup> This is a condensed version of the successes and needs list created at the Post-Season Assessment Meeting. For a complete list please contact NOAA-OGP.

	Successes	Needs — Areas for improvement
Preparedness	USAID complementary of SADC's role, led to increased preparedness     Facilitated long-term planning     Increased awareness of risks and feeling something can be done     Helped establishment of disaster management committees     Focused government response	<ul> <li>Difficult to manage user perceptions into useful mitigation strategies</li> <li>Plans for response must be further developed</li> <li>Governments generally did not have drought plans</li> </ul>
Results	Very accurate forecast for Namibia and Tanzania  User appreciation, particularly in Namibia, Zimbabwe, Tanzania, and Mozambique  Users able to provide value-added service for other end users  Forecast impact on markets  Namibia agriculture ministry adapted agronomic trials  Aided Namibia farmers' decision making  Reinforced crop diversification in Malawi & Zambia  Stock farmers stored feed in South Africa and bought animals during favorable grazing conditions	<ul> <li>Poor forecast in some countries</li> <li>Increased market volatility</li> <li>Users did not always have capacity to adjust decisions according to forecast</li> <li>Users interpretation of information did not always lead to good management solutions</li> <li>Small farmers who made poor decisions based on forecasts became skeptical</li> <li>Some farmers regretted not using information</li> <li>Suspension of water rights and loss of water distribution in some parts of Zambia</li> </ul>
<ul> <li>Enhanced communication with users</li> <li>Highlighted critical value of NMHS</li> <li>Collaborative efforts of international climate information community</li> <li>Emphasized capacity building</li> <li>Greater awareness &amp; interaction between users, NMHS and governments</li> <li>Users involved in SARCOF process</li> </ul>		<ul> <li>Capacity building not addressed fully for users and NMHS</li> <li>Lack of regional SARCOF contacts</li> <li>Users still thinking in deterministic terms</li> <li>No training program to enable NMHS to do forecasts</li> <li>Users need further help to understand probabilistic forecasts</li> <li>Inadequate definition of users</li> <li>Incomplete understanding of when decisions based on forecast are made</li> <li>Wider net of user sectors necessary — forestry, wildlife, fisheries, etc.</li> <li>Clearly define user needs and profiles</li> <li>Recommendations for mitigation strategies should be tied to existing methods for coping with climate variability</li> <li>Continued monitoring of users' reaction</li> <li>SARCOF process needs support from NMHS directors</li> <li>Institutionalize SARCOF within existing SADC institutions for sustainability</li> </ul>

• Strengthen NMHS/stakeholder interface

## Greater Horn of Africa (February 1998) and West Africa (May 1998) Regional Outlook

As hoped for in the original design concept encouraging self-sufficiency of applications activities, the Outlook Fora held in West Africa and the Greater Horn of Africa were regionally generated without prompting by NOAA-OGP. These two For afollowed the methodology designed and modified by the Southern Africa Regional Outlook Forum. Unlike the SARCOF, however, these regions plan to hold two meetings each year. The Greater Horn of Africa (GHA) experiences two rainy seasons per year, the long rains (March to May) and the short rains (September to December). Hence, the first Outlook Forum was coveyed in February 1998 to forecast for the long rains, while their second Outlook Forum in September 1998 combined a post-season assessment of the long rains Forum with a pre-season meeting for the short rains.<sup>19</sup> West Africa held its first Outlook Forum, Prevision Saisonniere en Afrique de l'Ouest (PRESAO-1), in Abidjan, Ivory Coast in May 1998, and they plan to hold a postseason assessment meeting in December 1998.

Both the PRESAO and the GHA Fora focused on building consensus precipitation Outlooks for the upcoming rainy seasons, but, like the regions in Latin America, they took the additional step of adding an applications focus to the Outlook Forum structure. PRESAO added a broad applications workshop which included agriculture, food security, water resources management, health, and environment, while the GHA Forum focused on regional food security and mitigation planning.<sup>20</sup>

The GHA Outlook Forum succeeded in bringing together more than 140 climate scientists and food security experts from all ten countries in the GHA region, along with international experts from other African countries, the IRI, the United States, and Europe. Together these experts dispelled rumors of an impending drought, indicating that

risks of widespread dry conditions in the region were low. However, they cautioned that the food security situation in the region remained precarious due in part to poor harvests in early 1997 and excessive rains late in the year. In addition to arriving at a consensus forecast, participants at the Outlook Forum explored ways to use climate forecasts to improve food security in the coming months and in the longer term. Both climatologists and food security specialists found the direct interaction from this multidisciplinary encounter valuable; climatologists learned more about tailoring their products to meet the needs of the food security community in the GHA, and food security specialists learned more about what climate forecasting has to offer and how this information might be integrated into disaster mitigation planning.

#### Outlook evaluation — Greater Horn of Africa<sup>21</sup>

Rainfall observations indicate the Greater Horn of Africa was unusually dry from March through May 1998 particularly in Sudan, where rainfall totals were generally less than 50% of normal, and in some regions less than 10% of normal. The Climate Outlook for most of Sudan (climatology), while including the possibility of dry conditions, was inconsistent with observations. Drier than normal conditions in northeast Ethiopia and Somalia were also inconsistent with the forecast of an increased chance of above normal precipitation in this region. The apparent discrepancy between the Outlook and observations is misleading, however, for two reasons: 1) the observation map in this region was based primarily on inaccurate satellite observations and is not representative of true rainfall observations (rain gauge data indicated wetter conditions that were more consistent with the Outlook), and 2) for much of this region, March through May is the dry season, and large departures from average rainfall in percent-normal

<sup>19</sup> Additional information regarding the September 1998 meeting is not included here, as it occurred after the 1997-98 El Niño event.

The full report of the PRESAO-1 meeting, including working group recommendations is available on the internet through the web pages of NOAA-OGP, ACMAD, and other major sponsors. The GHAForum report is available from DMC, Nairobi, and from USAID's Famine Early Warning System (FEWS).

<sup>&</sup>lt;sup>21</sup> For a description of the qualitative method used to evaluate the Outlook, see "Comparison of Climate Outlooks and Observations" in the Methodology section.

terms translates to a very small departure in actual rainfall amount. Participants in the GHA Forum generally felt the Outlook was accurate over the forecast period, and a detailed verification similar to the process employed in southern Africa is scheduled to be incorporated into future GHA Fora.

#### Climate Outlook - Rainfall

Statement from the Greater Horn of Africa Regional Climate Outlook Forum 9-13 February 1998, Nairobi, Kenya

#### **SUMMARY**

Near- to above-normal rainfall conditions over the period March-May 1998 are expected over much of the eastern part of the Greater Horn of Africa and equatorial inland areas. The indications for above-normal rainfall are strongest over the coastal parts of northern Tanzania, Kenya, coastal southern Somalia and north-eastern Ethiopia. Near- to above-normal rains are expected over the western part of the area. Near- to below-normal conditions are expected further south and in the central inland areas.

#### THE CLIMATE OUTLOOK FORUM

From 9-13 February 1998, a Climate Outlook Forum was convened to formulate consensus guidance for the March-May 1998 season in the Greater Horn of Africa. The Forum reviewed the state of the global climate system and its implications for this region. Among the principal factors taken into account are the major El Niño event of 1997-98 which is now apparently just passing its peak, very warm sea-surface temperatures in the western Indian Ocean, and warmer than normal sea-surface temperatures in the tropical Atlantic. The strong El Niño and warm sea-surface temperatures in the western Indian Ocean contributed significantly to the heavy rains over much of the region since October 1997. Although the relationship of sea-surface temperature variability in the Pacific and Indian oceans with the rainfall amounts during October-December over much of the region is relatively clear and well-established, its relationship with the rains from March-May is generally weaker (an exception is north-eastern Ethiopia). As a result, the March-May rains, in contrast to the October-December rains, are more difficult to predict.

#### **METHODOLOGY**

The regional climate assessment began with consensus agreement that the current El Niño and associated Indian Ocean sea-surface temperatures are expected to decay gradually over the forecast period (March-May 1998). This and other factors affecting the climate of the Greater Horn of Africa were assessed using coupled ocean/atmosphere models, physically-based statistical models and expert interpretation. The current status of seasonal-to-interannual forecasting allows prediction of spatial and temporal averages, and may not fully account for all factors that influence regional and national climate variabil-

ity. This Outlook is relevant only to seasonal time scales and relatively large areas; local and month-to-month variations may occur. Users are strongly advised to contact their National Meteorological and Hydrological Services for interpretation of this Outlook and for additional guidance.

The experts established probability distributions to indicate the likelihood of below-, near-, or above-normal rainfall for each subregion (see Map). Above-normal rainfall is defined as within the wettest third of recorded precipitation totals in each region; below-normal rainfall is defined as within the driest third of precipitation totals; near-normal is the third centered around the climatological median.

#### OUTLOOK

March to May constitutes an important rainfall season over the Greater Horn of Africa south of about 6°N, and in northeastern Ethiopia and eastern Eritrea. An exception is southern Tanzania.

Over the coastal areas extending from northern Tanzania to southern Somalia, normal to above-normal rains are expected. Normal to above-normal rains are also expected over the eastern half of Ethiopia, Somalia, Djibouti and the highlands of Eritrea as well as over Uganda south of 2°N, Rwanda, Burundi, western Tanzania, and western Kenya. Near- to below-normal rains are expected over northern Kenya and Uganda, extending northward into southern Sudan and the western half of Ethiopia and Eritrea. Over most of Sudan the rainy season does not start until after the forecast period. Therefore climatology is indicated.

#### PARTICIPANTS

Participants at the Forum included representatives of Meteorological Services from nine countries (Institut Geographique du Burundi; Djibouti Meteorological Department; Meteorological and Hydrological Service of Eritrea; National Meteorological Service Agency, Ethiopia; Kenya Meteorological Department; Direction Nationale de la Meteorologie et de l'Hydrologie, Madagascar; Uganda Meteorological Department; Rwanda Meteorological Service; Directorate of Meteorology, Tanzania) and climate scientists and other experts from national, regional and international institutes (WMO-CLIPS; Disaster Prevention and Preparedness Commission Ethiopia; DMC, Nairobi; DMC, Harare; Kenya Meteorological Society; USAID-FEWS, Ethopia; Water Department of Kenya; North Carolina State University; University of Nairobi; IRI; and NOAA-NCEP. Additional input was supplied by the U.K. Meteorological Office.

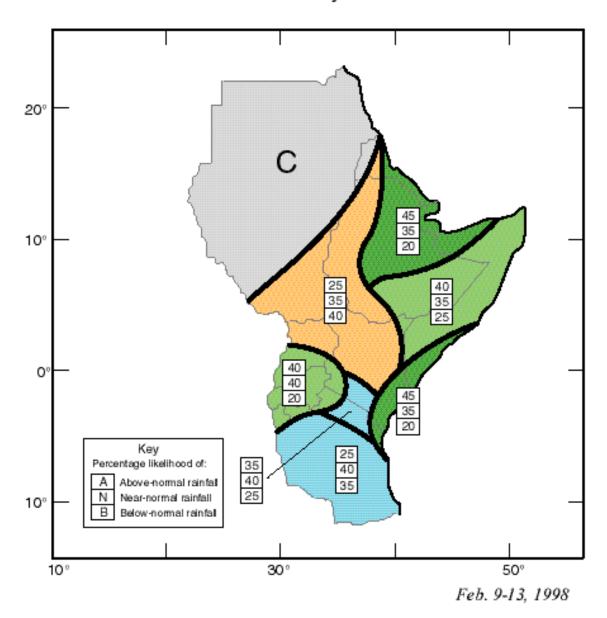
## **Consensus Climate Guidance**

## Greater Horn of Africa Regional Climate Outlook Forum

9-13 February, 1998 Nairobi, Kenya

(for list of participants and explanatory text see associated discussion)

## March - May 1998

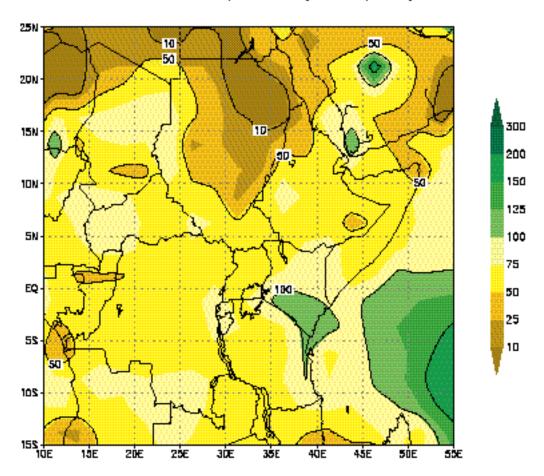


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International Research Institute
for Climate Prediction
Experimental Climate Forecast Division

#### Outlook evaluation — West Africa<sup>22</sup>

The Climate Outlook for July to September 1998 indicated increased likelihood for above-normal rainfall in southwestern West Africa (including Liberia and southern portions of Guinea, Sierra Leone, Côte dí Ivoire, Ghana, Togo, Benin and Nigeria). Estimated rainfall amounts for the Outlook period indicate near- to below-normal precipitation in most of this region, however. Near-normal conditions were observed in northwestern

Senegal and southwestern Mauritania, where the Outlook was for an increased chance of above-normal precipitation. For the remainder of West Africa, the Outlook was for climatology, or tercile probabilities similar to climatology. Estimated rainfall in these areas was generally in the near-normal range, with some areas, such eastern Niger, indicating above-normal conditions, and others, such as the northern portions of Mali and Mauritania, showing below-normal rainfall.

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<sup>&</sup>lt;sup>22</sup> For a description of the qualitative method used to evaluate the Outlook, see Comparison of Climate Outlooks and Observations in the Methodology section.

#### Climate Outlook - Rainfall

Statement from the First West African Regional Climate Outlook Forum 4-8 May, 1998, Côte d'Ivoire

#### **SUMMARY**

There are enhanced probabilities of above-normal West African rainfall for the period July to September 1998 over the Gulf of Guinea coast region, especially west of central Nigeria, and over northwestern Senegal and southwestern Mauritania. Across the Sahel there are enhanced probabilities of near-normal rainfall in those months.

#### THE CLIMATE OUTLOOK FORUM

From 4-8 May 1998, a Climate Outlook Forum was convened to formulate predictive guidance for the July to September 1998 rainy season in sub-Saharan West Africa. The Forum reviewed the state of the global climate system and its implications for this region. Among the principal factors taken into account were the major El Niño event of 1997-98, which has weakened slowly in recent months, and warmer-thannormal sea-surface temperatures (SSTs) that currently extend across much of the tropical Atlantic. Considerable research has established the linkages between SST anomalies in the tropical Pacific and Atlantic oceans and rainfall variability in sub-Saharan West Africa.

The Climate Outlook that follows assumes the present El Niño will weaken more rapidly during the next few months (following most model predictions), and that there will be no development of a tropical Atlantic SSTpattern that is known to accompany extreme sub-Saharan rainfall conditions. Any change in these expected SSTs will necessitate a revision of the Outlook statement. Careful monitoring of tropical Atlantic and Pacific SSTs is therefore needed during the next few months.

#### METHODOLOGY

The development of the West African Climate Outlook was performed using coupled ocean/atmosphere models, physically-based statistical models, and expert interpretation. Most of the statistical models used were developed by participants at the Pre-Forum Capacity Building Workshop on Seasonal Prediction in West Africa (23 February to 30 April 1998), held at ACMAD. The current status of seasonal-to-interannual forecasting allows prediction of spatial and temporal averages, and may not fully account for all factors that influence regional and national climate variability. This Outlook is relevant only to seasonal time scales and relatively large areas; local and month-to-month variations may occur. Users are strongly advised to contact their National Meteorological and Hydrological Services for interpretation and local adaptation of this Outlook, and for additional guidance.

The experts established probability distributions to indicate the likelihood of below-, near- or above-normal rainfall for each sub-region (see Map). Above-normal rainfall is defined as within the wettest third of recorded rainfall totals in each region; below-normal rainfall is defined as within the driest third of rainfall totals; near-normal is the third centered around the climatological median.

#### OUTLOOK

July to September receives on average 80% of the annual rainfall total in the Sahel zone, between 12° and 18° N. Further south to the Gulf of Guinea coast, July-September includes the Little Dry Season and hence is a less important period for annual rainfall. However, July-September rainfall anomalies can significantly affect agricultural production in this coastal region.

The probability of above-normal West African rainfall for the period July-September 1998 is 50% for northwestern Senegal and southwestern Mauritania, and also for the Gulf of Guinea coast region as far east as central Nigeria. Further east along the Gulf of Guinea coast region, over southeastern Nigeria and extending into Cameroon, that probability is reduced to 40% because tropical Atlantic SSTs have a weaker positive influence on rainfall there. Except in the extreme west, July-September 1998 rainfall across the Sahel is presently considered to be most likely in the near-normal (40%) or below-normal (35%) categories. The closeness of this probability of below-normal rainfall (35%) to that of the near-normal category (40%) stems from uncertainty about the longevity of the present El Niño. Since El Niño suppresses Sahelian rainfall, a slower weakening of El Niño than is currently predicted would increase the likelihood of below-normal Sahelian rainfall. For the extreme western Sahel, while the probability of near-normal rainfall remains the same as that for further east (40%) and higher than for the other two rainfall categories, above-normal rainfall is considered to be more likely (35%) there than below-normal rainfall (25%). This is the reverse of the situation for the rest of the Sahel, and instead reflects the influence of the tropical Atlantic SSTs.

#### **PARTICIPANTS**

Participants at the Forum included representatives of Meteorological Services from twelve countries (Benin; Côte d'Ivoire; Burkina Faso; Chad; Ghana; Guinea-Bissau; Guinea-Conakry; Mali; Niger; Nigeria; Senegal; Togo) and climate scientists and other experts from national, regional, and international institutes (ACMAD; WMO-CLIPS; Cooperative Institute for Mesoscale Meteorological Studies, University of Oklahoma; IRI; Laboratoire Météorologique Dynamique; Météo-France; North Carolina State University; NOAA-NCEP; ORSTOM, Brest; United Kingdom Meteorological Office; University of Zululand). Additional input was supplied by the European Centre for Medium-Range Weather Forecasts.

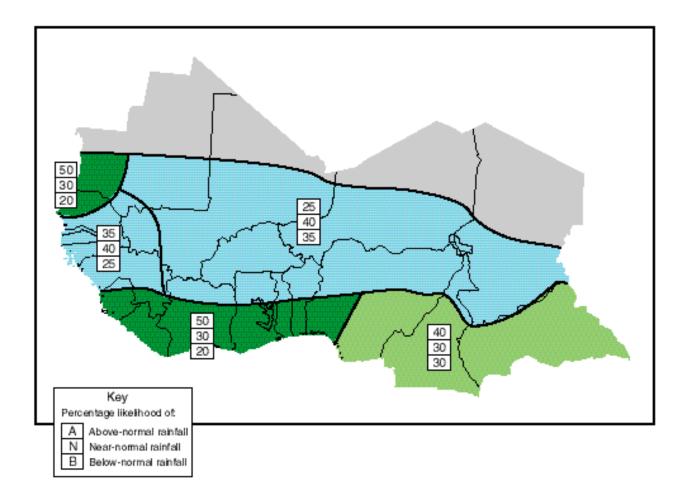
### **Consensus Climate Guidance**

## West African Regional Climate Outlook Forum

4-8 May, 1998 Abidjan, Ivory Coast

(for list of participants and explanatory text see associated discussion)

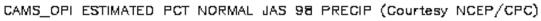
## July - September 1998

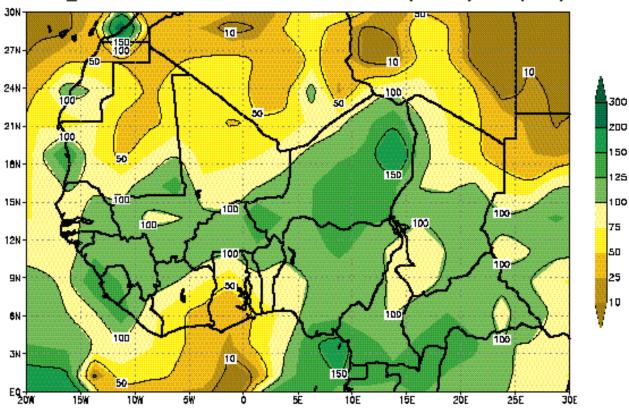




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